Frequently Asked Questions

December 2, 2005

Washington State Department of Transportation

State Materials Laboratory

And

Environmental Services Office Acoustics Division

Question #1: WSDOT is planning to test of Asphalt Rubber pavement in the summer ’06 on I-5 in the Lynnwood area

- Where exactly will the test take place?
- Will ½ mile be enough for full baseline test of Rubber modified asphalt pavement?
- Is it both sides of the freeway and if so, assuming the sensor is placed in the middle is ¼ mile sufficient to not pick up noise from the freeway not part of the test section?
- Are you planning to take baseline noise readings?
- Are they continuous readings or peak readings?
- For the test section, what manufacturing and application standards will be used? Are these posted anywhere?
- What independent firm will be used to test and interpret results?

1. ANSWERS: We are planning on constructing the first test sections on I-5, from 52nd Avenue West to SR-526 (southbound) project. The test sections run from milepost 188.65 to milepost 187.29, all lanes and shoulders of the southbound highway. The test section design consists of the following:

Section	Pavement Type	Length	Thickness
Trial Section #1	open-graded friction course with asphalt-rubber as a modifier	~½ mile in length	¾ (0.75) inch thick
Trial Section #2	open-graded friction course with SBS polymer as a modifier	~½ mile in length	¾ (0.75) inch thick
Control Section	Dense graded hot mix asphalt	½ mile in length	1.8 inch thick

The polymer modified binder that will be evaluated is a styrene-butadiene-styrene (SBS) modifier that has received high acclaim for improving performance in both Europe and the Untied States. SBS is a rubber-type modifier (but not the same as tire rubber) that gives bitumen the ability to stretch and resist damage and improves its cold-temperature flexibility. Note that the remainder of the project will use conventional dense graded HMA at 1.8 inches in depth.

WSDOT's Acoustics Section will conduct concurrent far field noise measurements with standard equipment, both near the roadway and at appropriate property lines. The intent is to have examples of pure noise from the roadway (sound intensity) and identify the noise levels that move from the road to people's property to show how it may change/mutate with terrain, other noise sources from traffic, etc. We are particularly interested in noise measurements that reflect the negative reaction from people's ears, not just where the rubber meets the road. The test sections provide adequate length to properly measure noise.

In addition, we are acquiring new noise measuring equipment that will measure the tire-pavement noise directly. This is called the "sound intensity" method and is being used in Arizona and California.

The open-graded friction course modified with asphalt-rubber will be constructed in accordance with the Arizona DOT specification and we have requested that an experienced representative from the Arizona DOT be present to assist with any production and laydown issues that arise. The open-graded friction course modified with polymer will be constructed in accordance with the Arizona DOT and the National Center for Asphalt Technology (NCAT) specifications. We have also requested an experienced representative from NCAT to be present during production and paving. We will post the designs on the State Materials Lab website (http://www.wsdot.wa.gov/biz/mats/) as soon as they are complete, which will be by early spring at the latest. We are posting the draft specification on our webpage today (please see the website listed above, under "Quieter Pavements").

The WSDOT State Materials Laboratory conducts pavement performance testing (smoothness, structural condition, rutting and friction) annually on all state highways as part of our Washington State Pavement Management System (WSPMS). We are members of the American Society for Testing and Materials (ASTM) and the American Association of State Highway and Transportation Officials (AASHTO) and we measure friction, roughness and rutting testing in accordance with their standards. WSDOT has over 40 years of experience in collecting pavement condition data and leads the nation in pavement management practices. In addition, the WSDOT will be working closely with the University of Washington on the analysis of this test section.

Question #2: WSDOT estimates an increase in cost of about $20 million/year for using Open Graded Friction Courses (OGFC) in Washington State.

- Will you please show your calculations and assumptions?
- Are you comparing conventional asphalt overlays (placed 1.8 inches deep) to OGFC placed 1½" deep?
- The "10 yr assumed life" for OGFCs - what is that based on?
- The current middle (truck) lane rutting on I-90, I-405 and I-5: Do you intend to permit this process to continue? If so, how long before the concrete structure is jeopardized and what cost and time is required for replacement?
- If an overlay is planned, what is the cost to prepare (grind) and overlay with conventional asphalt or OGFC? What life are you assuming with each in your calculations?

2. ANSWER: We based the potential cost increase on the number of lane miles of urban highways and the potential pavement lives for open-graded friction course quieter pavements. There are 2037.5 lane miles of urban highways with greater than 40,000 annual average daily traffic volumes where quieter pavements could be considered by policy makers. (Highways can be measured in centerline miles or in lane miles. A centerline mile measures the length of a highway and does not take the number of lanes into account. A lane mile is specific measure of highway length: one lane mile is one mile of highway that is one lane wide; a two lane highway of one centerline mile in length would have two lane miles).

   We assumed a 50 year analysis period, a discount rate of 4% and a cost to overlay of $140,000 per lane mile. An analysis period of 50 years allows for multiple life cycles and matches the expected pavement life of new concrete pavements. A discount rate of 4% comes from averaging the US Treasury's data on discount rates (which is a combination of the interest rate and the rate of inflation) over six decades. Our pavement costs for overlays currently average $140,000 per lane mile for dense graded HMA paved at 1.8 inches thick, which is our HMA standard overlay. We assume that the open-graded friction course pavements will be ¾ (0.75) inches in depth and will cost about the same per lane mile as the dense graded HMA.

California, Arizona and Texas have all noted that their open-graded friction course pavements cost about the same per lane mile as their dense graded pavements. We do expect initial costs for our trial projects to be more expensive due to the lack of experience in the paving industry with these types of pavements; however, this was not factored into our life cycle cost analysis.

Analysis period	50 Years
Discount rate	4.00%
Cost per lane mile	$140,000
Urban lane miles over 40,000 ADT	2037.5

One of the most important questions is the durability of the open-graded friction course pavements in our climate and with our traffic. Most states, including Georgia, California, Texas, Florida, Alabama and North Carolina have all reported system-wide average pavement lives in the 8-10 year range for open-graded friction courses, both rubber modified and polymer modified. Our dense graded HMA averages 16 year pavement life in western Washington. Our new concrete pavements are designed for a 50 year pavement life. Any reduction in pavement life increases the life cycle cost. Our calculations result in the following life cycle costs:

Frequency of Overlay (years)	Number of Overlays over 50-year Analysis Period	Present Worth Factor	Present Worth	Equivalent Uniform Annual Cost	Annual Cost for All Urban Miles	OGFC Additional Cost per Year
6	9	0.79	$574,225	$26,730	$55	$30
8	7	0.73	$447,262	$20,820	$42	$18
10	5	0.68	$370,798	$17,261	$35	$11
12	5	0.62	$321,065	$14,946	$31	$6

Question #3: Application Temperature: Arizona DOT's website states that the pavement surface temperature must be 85°F to place their asphalt-rubber modified OGFC and that given their summer temperatures; they have to wait for cooler winter temperatures to apply this type of pavement. Should the appropriate ambient air temp for our state be the published California DOT (Caltrans) standard of 55 °F?

3. ANSWER: Arizona DOT's specifications for placing open-graded friction courses modified with asphalt-rubber specify a minimum pavement surface temperature of 85°F. Specifically, Arizona DOT notes the temperature requirements as follows:

> **Arizona DOT specification:**
> **SECTION 414 - ASPHALTIC CONCRETE FRICTION COURSE (ASPHALT-RUBBER):**
>
> **414-7.06(A)(1)** **Dates and Surface Temperature:** the first paragraph of the Standard Specifications is revised to read:
>
> Asphaltic concrete shall be placed between the dates of **XXXXX** and **XXXXX** and only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 85 °F.

And from Arizona DOT's "Frequently Asked Questions Webpage":

> **6. Why aren't you continuing the program through the winter?**
>
> Rubberized asphalt cannot be applied during cold weather or very hot weather. The concrete pavement surface needs to be between 85 and 145 degrees Fahrenheit for the material to adhere properly. So rubberized asphalt can only be applied in the Spring and Fall in the Phoenix area – from March 15th to May 31st, and from September 1st to November 15th.
> (Source:
> http://www.azdot.gov/Highways/EEG/QuietRoads/fast_facts.asp)

We pave urban highways at night and nighttime pavement surface temperatures above 85°F are uncommon in western Washington. Arizona DOT specifically prohibits paving open-graded friction courses modified with asphalt-rubber below 85°F because of the potential adherence failures. Arizona also has concerns on high pavement surface temperatures, but that will not usually be a concern in western Washington at night. While Arizona's temperature restrictions do not prevent us from installing a test section, it is a very specific concern and risk.

Recognizing that the Arizona DOT specification would prohibit ever using their version of open-graded friction courses modified with asphalt-rubber, we have examined other specifications, including Caltrans, and discussed the issue with the Rubber Pavement Association. Our test project will use a specification that requires greater than 60°F air temperature. WSDOT will be closely monitoring and documenting both the air and surface temperature during placement of these materials for any potential impacts on long-term performance.

Question #4: Institutional Memory: The successful asphalt-rubber OGFC programs in Arizona, California, Texas and Florida require relatively tight temperature specifications for the manufacture and application. Their specifications for construction require specialized equipment (holding mixing tanks) for application. Has WSDOT ever done this type of pavement before?

4. ANSWER: WSDOT has never placed a current generation design of open-graded friction course modified with rubber or other polymers, which is why we are trying a test section in 2006. We do know that states that regularly use these pavements report system-wide average pavement lives of 8-10 years and those pavement lives compare poorly to either our standard dense graded HMAs (16 years average system-wide in western Washington) or concrete pavement (50 years).

   We have placed asphalt pavements that were modified with rubber, but they were not considered as having any noise reducing effects. Those pavements had slightly poorer performance than our standard dense graded HMAs, but were much more expensive due to the cost of the rubber modified asphalt.

   WSDOT is actively involved in the evaluation of a number of products/processes that could potentially improve pavement performance. These studies, similar to the one we are conducting for the open-graded test sections, provide WSDOT with the ability to evaluate the design, construction and performance characteristics of the new product or process. If found to provide benefit (both in life-cycle cost and performance), WSDOT will incorporate into our standard practices.

Question #5: Studded Tires: In contrast to the conventional asphalt in use by WSDOT, asphalt-rubber OGFC consists of melted crumb rubber and roughly double the content of asphalt binder (glue) which one would expect to result in a more cohesive and tougher surface than conventional asphalt overlays now in use. Will asphalt-rubber OGFC better resist studded tires than the conventional asphalt pavements now in use by WSDOT?

5. ANSWER: These are important questions: How durable are open-graded friction courses modified with polymers (either rubber or others) in western Washington under our climate and traffic? What is the initial noise reduction from these quieter pavements and how durable is that noise reduction over time? What is the total life cycle cost? The trial project in 2006 is intended to start to provide data to answer these significant questions and to provide answers. As the pavement wears over time, especially over the next 8-12 years, we will have better information on the durability of the pavement and of the noise characteristics.

   Studded tire usage in Washington State is a factor with which many states using open-graded friction courses do not have to contend. Florida, Arizona, Georgia, Texas and California do not see studded tire usage on their highways, even where such usage is legal. In addition, these southern tier states have more favorable weather conditions for placing open-graded friction courses (modified with either polymers or asphalt-rubber).

Question #6: With sections of concrete pavement along I-5 being rutted, what is the cost and construction time difference between overlaying the concrete pavement with HMA vs. replacing the concrete pavement? Is it WSDOT's policy to not overlay in favor of using the concrete until replacement is required?

6. ANSWER: WSDOT selects the type of pavement to be used on a highway based on a number of factors. Our Pavement Type Selection Protocol (available online here: http://www.wsdot.wa.gov/biz/mats/pavement/Technotes/PTSP_Jan2005.pdf) covers three main areas, including an analysis of the pavement foundation, a life cycle cost analysis and an engineering analysis. Many, but not all, urban highways with high traffic volumes result in selection of concrete pavement as the preferred pavement type. Concrete pavements tend to perform better under high traffic volumes and they also tend to resist studded tires better than asphalt pavements.

   We are studying new surface treatments for concrete that may reduce noise from our traditional treatment. We have test sections installed on I-5 in Federal Way (at the new 317th direct access interchange) and on I-90 in Spokane. We will begin measuring the tire-pavement noise on these pavements in 2006.

We have several strategies for extending the useful life of our concrete pavements. When a large percentage of these concrete pavements were built in the 1960s and 1970s, the designers only expected 20 years of useful life before they would be replaced. We have now had over 40 years of useful life and that might well extend to over 50 years before the pavements are replaced.

Our new concrete pavements are being designed for 50 year design lives. Disruption to traffic while overlaying asphalt pavements is a serious issue in urban areas. Daytime asphalt paving is almost never an option on urban freeways. As traffic volumes build the available window for nighttime paving shrinks every year. Long lasting pavement surfaces on urban freeways keep traffic flowing and reduce lane closures, which is why much of the urban freeway system is concrete.

We do have challenges on pavement durability and studded tire wear is one of the most critical. Over time, studded tires wear away the pavements; more slowly for concrete than for asphalt, but both pavements are affected. We can grind concrete pavements to remove studded tire damage and to restore a smooth surface using large diamond grinders. If the concrete pavement is in good structural condition then diamond grinding can be very effective: I-5 from the north end of Boeing Field to Southcenter was diamond ground in the late 1990s and is performing well. Funding constraints drives our ability to restore concrete pavements; generally, the most recent gas tax increases focus on new projects rather than rehabilitating older concrete pavements. There is funding for some work on I-5 through Seattle, with funding for the work beginning in 2013.

Over time, heavy truck traffic causes the individual concrete panels to tip, or “fault,” resulting in that rhythmic “thump, thump, thump” that is so noticeable on I-5 south of Federal Way. Our new concrete pavements incorporate dowel bars (1-1/4 inch diameter steel bars) at each panel joint to prevent this faulting. Unfortunately, pavement designers had no knowledge of the drastic increase in today’s traffic back in the early 1960s and 1970s and the benefits we now know about dowel bars and how they improve our concrete pavement performance. Dowel Bar Retrofit projects correct this problem.

Over the last 10 years WSDOT has been rehabilitating some concrete pavements by a process knows as “dowel bar retrofitting”. In this process, we have private construction firms go back and install dowel bars at each panel joint. We also remove and replace any severely damaged panels and then we grind the pavement smooth using diamond grinders. The average costs for this process is approximately $330,000 per lane mile, but only the truck lane(s) needs to be retrofitted (usually either the far right lane or two far right lanes, depending on total number of lanes on the highway).

We generally do not overlay concrete pavements with asphalt. Very thick depths of asphalt must be used or the cracks in the concrete reflect up through the asphalt, creating a very bumpy road. Usually a minimum of 4 inches of asphalt is required to prevent, or at least delay, this reflective cracking. We are interested in claims from some states that rubber modified pavements do a better job of delaying reflective cracking. Arizona DOT has been installing rubber modified asphalt over concrete at 1-1/2 inch depths and is reporting good performance compared to their standard dense graded asphalts. Most of these pavements in Arizona are too new to determine their life cycle or their pavement life. We are looking for a trial project to install a rubber modified asphalt pavement over an existing concrete pavement. We need both a good location and funding to make this happen and are still aiming to get a trial project built in 2006.